**1. Definition and Importance of the Sector**

The aerospace sector is an industry concerned with the design, manufacture, operation and management of air and space vehicles operating inside and outside the atmosphere. This sector is divided into many sub-branches such as commercial aviation, military aviation, space exploration, satellite technologies and air transport.

Aerospace studies promote scientific discoveries and provide critical technologies in many areas such as communication, navigation, defence and transportation. Satellite systems enable worldwide communication, while space exploration creates great opportunities to discover new planets and better understand the universe. The aviation sector has a significant impact on the economy, tourism and trade by enabling global transport.

Emerging technologies require the sector to continuously develop innovative solutions, and both public and private sector investments are shaping the future of space and aviation.

**2. Job Areas in the Sector (Computer Engineering Perspective)**

Computer engineers can work in the following areas in aerospace and aviation:

- Embedded Systems and Software Development → Development of aircraft, drone and satellite software

- Autonomous Systems & Artificial Intelligence → Autonomous aerial vehicles, space robots, space exploration systems

- Data Analytics and Big Data → Satellite imaging systems, air traffic data analysis

- Cyber Security → Software security of space and air vehicles, satellite security

- Network and Communication Systems → Satellite communication protocols, inter-aircraft communication

- Simulation and Modelling → Flight simulators, airflow modelling, space mission simulations

- Cloud Computing & Remote Control Systems → Satellite management, aircraft maintenance software, ground station management

**3. Ecosystem of the Sector**

- State Agencies → NASA, ESA, Roscosmos, ISRO, TUA (Turkish Space Agency)

- Private Companies → SpaceX, Blue Origin, Boeing, Lockheed Martin, Airbus

- Defence & Aerospace Companies → Companies operating in the field of military and civil aviation

- Universities & Research Centres → Research institutions such as MIT, Stanford, ITU, TUBITAK SPACE

- Startup Ecosystem → New generation space and aviation initiatives (e.g. Rocket Lab, Relativity Space)

**4. Technological and Industrial Developments**

**1. Artificial Intelligence Assisted Space Missions (such as NASA's Perseverance Rover)**

Companies & Institutions:

- NASA & JPL (Jet Propulsion Laboratory) → Perseverance, Curiosity, Ingenuity (Mars Helicopter)

- ESA (European Space Agency) → ExoMars Rover, artificial intelligence-based data analysis

- Blue Origin → Autonomous landing systems and AI-based analyses

- SpaceX → Autonomous navigation systems

- Google AI & IBM Watson → AI applications in joint projects with NASA

**2. Autonomous Space Vehicles and Robotic Systems**

Companies & Institutions:

- NASA → Mars Rovers, Dragonfly (drone to be sent to Saturn's Titan moon)

- Boston Dynamics & NASA JPL → Robotic exploration systems in space

- iSpace (Japan) → Autonomous lunar landers

- Astrobotic & Intuitive Machines → Autonomous landing systems developed for NASA's lunar missions

**3. Reusable Rocket Technologies (SpaceX's Falcon 9 and Starship projects)**

Companies:

- SpaceX → Falcon 9, Falcon Heavy, Starship

- Blue Origin → New Shepard, New Glenn

- Rocket Lab → Electron rocket (reusable first stage)

- Relativity Space → Reusable rockets produced by 3D printing

**4. Small Satellite & CubeSat Technologies**

Companies

- Planet Labs → Small satellite imaging systems

- Rocket Lab → Launch systems for small satellites (Photon platform)

- SpaceX → Starlink CubeSat-based internet network

- Blue Canyon Technologies → CubeSat production for NASA and private companies

- TÜBİTAK UZAY & TUA → Turkey's CubeSat projects

**5. Digital Twin Applications in Aviation**

Companies

- Boeing → Digital twinning in aircraft design and maintenance processes

- Airbus → Digital twin technology for aerospace production optimisation

- NASA → Use of digital twins for spacecraft and mission simulations

- GE Aviation → Digital twin models for engine performance analyses

**6. Cloud Computing and Data Analytics in Space**

Companies:

- Amazon AWS (AWS Ground Station) → Cloud-based analytics for satellite data

- Microsoft Azure Space → Cloud solutions that analyse satellite and space data

- Google Cloud & NASA → Big data processing and analytics solutions for space exploration

- IBM & NASA → AI-powered big data analyses.

**5. Which Companies are Industry Leaders? What Shows Potential for the Future?**

**1. BAE Systems**

- BAE Systems is the UK's largest manufacturer of advanced aerospace and defence solutions.

- The company was formed in 1999 following an acquisition and merger between Marconi Electronic Systems (MES), a subsidiary of General Electric Company (GEC), and British Aerospace (BAe). The company's history dates back to 19th century shipbuilders!

- With more than 93,000 employees in 40 countries, BAE Systems has more than 50 sites in the UK alone. BAE is a leading global developer of defence and combat technology, producing military aircraft, naval vessels and combat vehicles, as well as ammunition and artillery systems.

- The company is most famous for producing the Eurofighter Typhoon. Typhoon is the result of a collaboration between the United Kingdom (with BAE Systems as a major partner) and several European countries, including Germany, Italy and Spain.

**2. Rolls-Royce**

- Rolls-Royce's first aircraft engine was the Eagle, which was developed in 1915. The Eagle was the first engine to make a non-stop trans-Atlantic flight possible. It played a significant role during World War I, powering a variety of aircraft due to its reliability and performance. The development of the Eagle marked Rolls-Royce's entry into the aviation industry, setting the stage for its future as a leading manufacturer of aircraft engines.

**3. Boeing**

- American aerospace company Boeing is the third-largest aerospace manufacturing company in the world and amongst the top ten aircraft manufacturers

**4. Airbus**

International aerospace company Airbus works across both the commercial and defence sectors. Founded in 1970 and based in Toulouse, France, Airbus are a relative newcomer to the aerospace industry but quickly established itself as a top player and now boasts 130,000 employees across 180 locations worldwide.

**5. Lockheed Martin**

Lockheed Martin is an aerospace and defence company with expertise in aircraft, satellite and cyber technologies. Headquartered in Maryland, USA and London, UK, the company employs more than 100,000 people worldwide and has more than 375 facilities worldwide.[(1)](https://airframedesigns.com/what-are-the-top-5-aerospace-manufacturing-companies/?utm_source=chatgpt.com)

**Leading Turkish Companies in the Sector**

**1.BAYKAR**

Baykar's culture of continuous production and development plays a leading role in the success of Baykar's defence technologies, which are included in the inventory of the Turkish Armed Forces and exported abroad. At our Baykar R&D Centre, which is registered by the Ministry of Industry and Technology, we focus on designing advanced technologies that will bring about a paradigm shift in the aviation arena in a national and indigenous manner. The intertwining of R&D and production processes ensures the dynamic implementation of new technologies. In addition to designing, making and producing, they are also working to ensure that unmanned and autonomous technologies are embraced by the military, industrialists and all layers of society. [(2)](https://www.baykartech.com/tr/biz-baykariz/)

**2.ASELSAN**

ASELSAN, Turkey's largest defence electronics company, has a wide range of products to meet the needs of the Turkish Armed Forces in particular, as well as domestic and foreign requirements, in communication and information technologies, radar and electronic warfare, electro-optics, avionics, unmanned systems, land, naval and weapon systems, air defence and missile systems, command and control systems, transportation, security, traffic, automation and health technologies. Today, ASELSAN has become a brand that exports its indigenous products, ranks among the world's top 100 defence industry companies (Defense News Top 100), establishes partnerships in international markets by building cooperation models with local institutions, and makes investments.[(3)](https://www.aselsan.com/tr/hakkimizda)

**3. ROKETSAN**

Roketsan was established on 14 June 1988 with the decision of the Defence Industry Executive Committee with the aim of ‘meeting the rocket and missile needs of the Turkish Armed Forces (TAF) and having a leading institution in the design, development and production of rockets and missiles in our country’.[(4)](https://www.roketsan.com.tr/tr/biz-kimiz/hakkimizda)

**4.TAI**

Turkish Aerospace Industries Corporation (TAI) was established on 28 June 1973 under the Ministry of Industry and Technology in order to reduce Turkey's foreign dependence in the defence industry.

Before the 25-year period was completed, the foreign shares of TAI were acquired by Turkish shareholders in 2005 and the company was restructured. In this context, TAI and TAI merged and expanded their activities under the umbrella of TAI - Türk Havacılık ve Uzay Sanayii A.Ş. and became Turkey's technology centre in the development, modernisation, production, system integration and life cycle support processes of aerospace industry systems,

**5.HAVELSAN**

HAVELSAN is one of Turkey's leading technology companies, established in 1982 as a subsidiary of the Turkish Armed Forces Foundation. Thanks to its long years of experience and highly qualified human resources, it provides high technology based software intensive products, solutions and services for the armed forces, public and private sectors in Turkey and abroad.

- Command, Control and Defence

- Simulation and Training

- Information and Communication Technologies

- Robotics and Unmanned Autonomous Systems

- Cyber Security

has signed many reference projects in national and international markets and continues to offer its solutions consisting of original products and systems to its customers.[(5)](https://www.havelsan.com/tr/hakkimizda)

**Indicators of Potential for the Future:**

**1.Rocket Laboratory**

They started with small launches and pioneered an industry-breaking launch vehicle called Electron, which is now the second most frequently launched rocket in the US. But they haven't stopped launching small satellites. They are currently developing the next generation large launch vehicle Neutron to launch future constellations and large spacecraft missions that will provide vital data and services to Earth.[(6)](https://www.rocketlabusa.com/about/about-us/)

**2.Relativity Space**

Their iterative development approach revolutionises the design-to-flight process, enabling them to scale to meet customer needs.

Their focus: delivering exceptional launch services that are highly competitive in the market. They design and manufacture optimised, cost-effective, high-performance and reusable rockets for customers.[(7)](https://www.relativityspace.com/about)

**3.AST SpaceMobile**

AST SpaceMobile is building the first and only global cellular broadband network that will work directly with standard, unmodified mobile devices in space, based on our extensive IP and patent portfolio. Engineers and space scientists have made it their mission to eliminate the connectivity gaps faced by today's five billion mobile subscribers and ultimately bring broadband to the billions who remain unconnected.[(8)](https://ast-science.com/company/)

**4.TÜBİTAK UZAY & TUA**

TÜBİTAK UZAY is Turkey's leading research and development organisation in the rapidly developing field of space technologies. In order to ensure the technological independence of our country, it develops many subsystems and application projects such as domestic and national operational satellites, communication systems, star trackers and flight computers.[(9)](https://uzay.tubitak.gov.tr)

**6. Challenges in the Sector**

- Advanced safety requirements → The margin of error in aerospace systems must be close to 0 per cent.

- Long development processes → A spacecraft or aircraft can take years to develop.

- Certification and regulations → There are strict controls on aerospace software (such as DO-178C).

- Software development challenges in space → Delay, low data transfer rates, high radiation environment.

**7. Qualifications Required to Work in the Sector**

Computer Aided Engineering (CAE):

**- CAD (Computer Aided Design):** Development and revision of 3D modelling of spacecraft systems, building contents and technology.

**- CAE Software:** Computer-aided engineering solutions for simulation and analysis with software tools for solving technical problems.

**- FEA (Finite Element Analysis):** Using specialised software to reduce computational costs and similarly to study the properties of aerospace structures under different loads.

**- CD (Computational Fluid Dynamics):** The use of computer technology for fluid simulation and its effects on the operations of aeronautical vehicles.

Programming Skills:

**- MATLAB/Simulink:** Common engineering calculations, simulations and modelling.

**- Python:** A ubiquitous coding language for engineering tasks. One of the basic skills required for aerospace engineering.

**C/C++:** Essential for programming embedded systems in various aerospace projects. Essential for developing programmes for various aviation projects.[(10)](https://www-pitchnhire-com.translate.goog/blog/skills-needed-for-aerospace-engineering?_x_tr_sl=en&_x_tr_tl=tr&_x_tr_hl=tr&_x_tr_pto=tc&_x_tr_hist=true)

**8. Future of the Sector (From the Computer Engineering Perspective)**

Autonomous space missions → Space exploration without human intervention

Mega satellite constellations (such as Starlink) → More powerful communication infrastructures

Digital twin & Simulation technologies → Simulation of aircraft

Artificial intelligence and quantum computing in aviation

Cyber security and space-based data protection

**9.Personal Evaluation**

In particular, innovations in areas such as autonomous systems, artificial intelligence and data analytics are making great contributions to aerospace engineering. For example, robotic systems used in space missions or software that improves the safety of aircraft show the importance of computer engineering in this sector.